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PLANKTONIC OSTRACODS OF THE NORTH ATLANTIC OFF BARBADOS

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ABSTRACT

Some 46 species of ostracods have been found in samples collected biweekly from 1967–1969 in 0–400-m hauls at Station 2B off the west coast of Barbados and in other plankton tows from varying depths made in the vicinity of Barbados. The commonest species within the upper 400 m were *Archiconchoecia striata, Halocypris inflata, Conchoecia curta, C. magna, C. microprocera, C. procera, C. oblonga, C. parthenoda,* and *C. spinirostris*. The total numbers of ostracods caught during the year gave a mean of 5.9/m³ or 2,360/m² of sea surface. Highest numbers of 23.9/m³ were taken in April 1968; numbers were minimal in December 1967. The most abundant species were *C. spinirostris* with a mean of 653/1,000 m³, *C. curta* (mean 654/1,000 m³), the *procera* species together (mean 1,081/1,000 m³), *A. striata* (mean 348/1,000 m³), and *C. oblonga* (mean 219/1,000 m³). At Station 2B the total number of species recorded per sample ranged from 3 to 23, but usually 12–20 species were present in the 0–400-m hauls. A new subspecies of *Euconchoecia chierchiae* which lacks a point on the left rostrum and a posterodorsal point on the right shell is described, as is the female of *Conchoecia allotherium* Müller, which hitherto it has not been possible to differentiate from the female of *C. oblonga*.

As part of a study of plankton productivity in the tropical western North Atlantic, zooplankton samples were collected biweekly for over two years at Station 2B at 13°15′N, 59°42′W approximately 10 km west of Speightstown on the west coast of Barbados. The general results and the hydrographic data are contained in a report from the Bermuda Biological Station (Steven et al., 1970). The data for biomass and species composition of the zooplankton have been given by Moore and Sander (1977), who have also compared the copepod population at this offshore station with that at an inshore station off Bellaire Research Institute on the west coast (Sander and Moore, 1978). Through the courtesy of Drs. Moore and Sander the ostracods contained in the samples collected between September 1968 and December 1969 have been identified and counted. At Station 2B the depth of water is 460 m and oblique plankton tows were made with a 0.5-m net of No. 6 mesh (0.239 mm aperture) from 400 m to the surface. The ostracods were also examined from some deepwater stations visited during a cruise on C. S. S. HUDSON between Barbados and Tobago in March–April 1968. Other samples available for study included zooplankton hauls made by Dr. Carol Lalli with 150, 300, and 950 mw [mw (m of wine)] with similar 0.5-m nets at several stations off the west coast of Barbados. Most of these collections were made from relatively shallow depths of 400 m or less, so few bathypelagic species have been caught. From these several collections some 46 species have been recorded, including those already noted (Deevey, 1970) from Station 1B 13 km west of Barbados in 450 m of water.

Barbados lies in the North Atlantic east of the Lesser Antilles Arc which essentially separates the Caribbean Sea from the open Atlantic at depths greater than 1,000 m. The waters around Barbados are characterized by a salinity inversion between 75- and 150-m depths, where highest salinities of up to 37‰ may be found. The surface waters are of exceptionally low salinity, which may vary from 33.5 to 36‰ at different times of year. In 1967–68 lowest salinities were noted in July or August and salinities increased to December or January, and

then decreased again, but wide variations may occur from week to week. At Station 2B below 100–150 m salinities decrease from 36.4–37‰ to about 35–36‰ at 400 m, although a second increase may be found at 300 m. In general, the low surface salinity is attributed to drainage from the Amazon and Orinoco Rivers and to precipitation over the South Equatorial Current (Beers et al., 1968). Low salinity water masses with high silicate concentrations are believed to originate from the Amazon River, and at Station 2B an inverse correlation between salinity and silicates has been found. Steven et al. (1970) noted that several such low salinity lenses may be formed annually; these move westerly and in 1968 arrived near Barbados between late January and September. The zooplankton, especially the copepods, from such low-salinity lenses have been studied by Calef and Grice (1967).

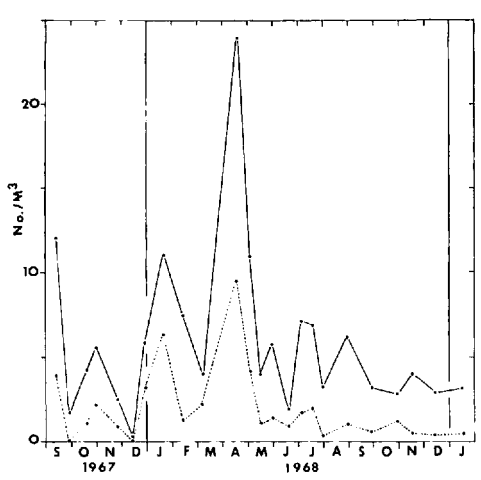
In these tropical waters the isotherms are nearer the surface, as has been well demonstrated by Fasham and Angel (1975, fig. 3) for a transect from the eastern North Atlantic between 10° and 60°N at longitude 20°W. The temperature decreases more rapidly with depth than in more northern waters. At 200 m at Station 2B the temperature variations are similar to those noted between 150 and 500 m in the Sargasso Sea off Bermuda; at 300 m the temperatures are comparable to those at 600–700 m and at 400 m they are similar to those at 800–900 m in the waters off Bermuda at 32°N. Within the upper 400 m the planktonic organisms living in these waters may be subjected to salinities ranging from 33.4–37‰ and temperatures of from 10–29°C. This range is not seasonal, although highest temperatures and lowest salinities were noted in summer during the period studied. The upper 50 to 75 m were generally isothermal during the year, with a range of 25–29°C. At 100 m the temperatures ranged from 23.0–26.5°C, at 200 m from 15–20° C, at 300 m from 12.7–13.5°C, and at 400 m from 9.3–11.6°C.

Ostracods

Of the total zooplankton collected at Station 2B, ostracods constituted a mean percentage of 3.7% in the oblique 400–0-m hauls and 1.8% in the surface samples (Moore and Sander, 1977). In other plankton tows off the west coast of Barbados ostracods made up 2.0–4.8% of the total numbers of organisms caught by the No. 6 mesh nets. No marked seasonal variations in total quantity of zooplankton measured by displacement volumes and dry weights were noted at Station 2B, but in general more organisms were present in 1968 than in 1969. Copepods were by far the dominant group, followed in abundance by Foraminifera, chaetognaths and ostracods. In the oblique hauls the total numbers of animals averaged 155 ± 14/m^3; a mean total of 5.9/m^3 or 2,360/m^2 was obtained for the ostracods.

The variations in numbers of ostracods from September 1967 to January 1969 are shown in Figure 1 which also shows the numbers of unidentifiable juveniles. These juveniles constituted 27.8% of the total numbers of ostracods and the variations in numbers reflected the occurrence of swarms of juveniles. Highest numbers were noted in September 1967 and January and April 1968; from May 1968 to January 1969 only small numbers of ostracods were present, although the total quantity of zooplankton remained relatively high throughout 1968. Breeding activity was greatest in April when highest numbers of 23.9 ostracods/m^3 were caught, but it is not clear that this was a seasonal phenomenon that would occur in other years. The numbers of ostracods recorded were higher when quantities of nitrates and phosphates were greater but apparently bore no relation to the concentration of chlorophyll or the periods of higher or lower salinities in the surface waters.

Table 1 lists the species of ostracods that have been found in Barbados waters



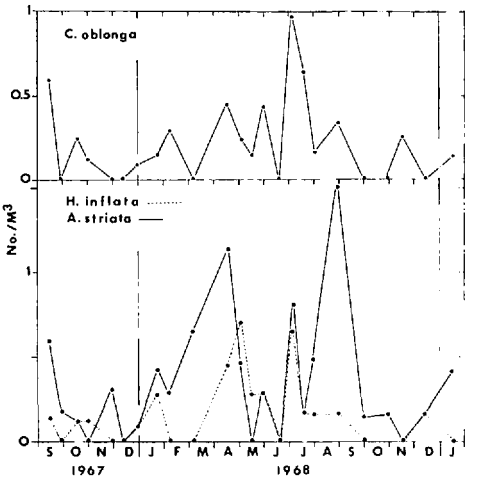


Figure 1. (Left) Variations in numbers/m³ of the total numbers of ostracods, solid line, and of the unidentified juveniles, dotted line, from September 1967 to January 1979 at Station 2B.

Figure 2. (Right) Variations in numbers/m³ of *Archiconchoecia striata, Halocypris inflata,* and *Conchoecia oblonga* from September 1967 to January 1969 at Station 2B.

and gives the period of occurrence and depth of tows. Year-round data are available only from Station 2B where some 30 species were recorded; data for deeper-living species are fragmentary. The commonest and most numerous species within the upper 400 m were *Archiconchoecia striata, Halocypris inflata, Conchoecia curta, C. magna, C. microprocera, C. oblonga, C. parthenoda, C. procera,* and *C. spinirostris,* but *C. acuminata, C. atlantica, C. bispinosa, C. elegans, C. porrecta, C. rotundata,* and *C. spinifera* were also taken year-round. *C. concentrica, C. echinata, C. imbricata, C. secernenda, C. subarcuata* and *Fellia bicornis* occurred fairly frequently. All these species except *C. echinata* and *F. bicornis* are epipelagic in these waters and have also been caught in tows within the upper 150 m. Species found only in samples from below 400-m depths include *C. allotherium, C. ametra, C. convexa, C. hyalophyllum, C. macroprocera, C. pusilla, C. skogsbergi, C. stigmatica* and *C. valdiviae.*

A few of the species recorded from the eastern Caribbean off Venezuela (Deevey, 1978a) have not as yet been found off Barbados, including *Fellia cornuta, C. dentata, C. edentata, C. incisa, C. kampta, C. mollis, C. reticulata* and *C. rhynchena,* doubtless because the deeper waters were not sufficiently sampled. Several species found off Barbados (*Archiconchoecia bispicula, C. nasotuberculata, C. valdiviae, C. pseudoparthenoda,* and *C. hyalophyllum*) were not noted in Venezuelan waters. Most of the species common in Barbados waters are also common in the Sargasso Sea off Bermuda (Deevey, 1968; Deevey and Brooks, 1980; Angel, 1979), but several of these occur only occasionally or rarely or have not been recorded from the Sargasso Sea. *C. acuminata, C. atlantica, C. porrecta, C. subarcuata* and *C. bispinosa* are not as common at 32° N. *C. concentrica, C. macrocheira, C. nasotuberculata* and *Fellia bicornis* have been rarely noted, and *C. echinata* has never been recorded from the Sargasso Sea.

At Station 2B the total number of species recorded per sample ranged widely from 3 in late November and early December 1967 to 23 in May 1968. Only 14 species were noted in April when highest numbers were present. Usually 12–20 species were found in the 400–0 m samples.

Table 1. The species of Ostracods, with their periods of occurrence and depth ranges. Species previously recorded are marked with an asterisk

Species	Occurrence and Depth Range
**Fellia bicornis* (Müller), 1906	Occasional, October to June, 400–0 m and deeper
**Halocypris inflata* (Dana), 1849	Common year-round, 0–400 m
**Euconchoecia chierchiae* Müller, 1890	Occasional, January to September, 0–400 m
**E. chierchiae aspicula*, n. subsp.	March–April, 0–400 m
Archiconchoecia bispicula Deevey, 1978	July, October, 0–400 m
A. cucullata (Brady), 1902	Occasional, only from 800–950 mw samples
A. fabiformis Deevey, 1978	December, 0–400 m
**A. striata* Müller, 1894	Common year-round, 0–400 m
**Conchoecia acuminata* (Claus), 1890	Common year-round, 0–400 m
C. aequiseta Müller, 1906	January, April, 900–0 m
C. allotherium Müller, 1906	May, 895 mw
C. ametra Müller, 1906	One shell only, January, 950 mw
**C. atlantica* (Lubbock), 1856	Common year-round, 0–400 m
**C. bispinosa* Claus, 1890	Common year-round, 0–400 m
**C. concentrica* Müller, 1906	Occasional year-round, 0–400 m
C. convexa Deevey, 1977	April, 900–0 m
**C. curta* Lubbock, 1860	Common year-round, 400–0 m
**C. daphnoides* (Claus), 1890	Occasional year-round, 900–0, 400–0 m
**C. echinata* Müller, 1906	Occasional year-round, 400–0 m
C. echinulata (Claus), 1891	Relatively rare during year, 400–0 m
**C. elegans* Sars, 1865	Common year-round, 400–0 m
C. hyalophyllum Claus, 1890	February, May, 0–400 m, 895 mw
C. imbricata (Brady), 1880	Relatively rare year-round, 900–0, 400–0 m
C. inermis (Claus), 1890	March, May, 1,000–0 m
C. lophura Müller, 1906	January, March, 1,000–0 m
C. loricata (Claus), 1894	January, March, April, 1,000–0, 0–400 m
C. macrocheira Müller, 1906	Occasional year-round, 900–0, 400–0 m
C. macroprocera Angel, 1971	May, 895 mw
**C. magna* Claus, 1874	Common year-round, 400–0 m
C. microprocera Angel, 1971	Common year-round, 400–0 m
**C. nasotuberculata* Müller, 1906	Occasional year-round, 400–0 m
**C. oblonga* (Claus), 1890	Common year-round, 400–0 m
**C. parthenoda* Müller, 1906	Common year-round, 400–0 m
**C. parvidentata* Müller, 1906	September, 400 m
**C. porrecta* Claus, 1890	Common year-round, 400–0 m
**C. procera* Müller, 1894	Common year-round, 400–0 m
C. pseudoparthenoda Angel, 1972	Relatively rare, 400–0 m
C. pusilla Müller, 1906	January, March, April, 900–0 m
**C. rotundata* Müller, 1890	Common year-round, 400–0 m
**C. secernenda* Vavra, 1906	September to June, 0–400 m
C. skogsbergi Iles (?)	May, 900–0 m
**C. spinifera* (Claus), 1890	Relatively common year-round, 400–0 m and deeper
**C. spinirostris* Claus, 1874	Common year-round, 400–0 m
C. stigmatica Müller, 1906	January, March, April, 900–0 m
**C. subarcuata* Claus, 1890	Occasional year-round, 400–0 m
C. valdiviae Müller, 1906	January, 900–0 m
**Conchoecia* sp.	September, May, 400 m

Family HALOCYPRIDIDAE Dana
Subfamily ARCHICONCHOECINA Poulsen
Genus *Archiconchoecia* Müller

Four species of this genus were recorded, of which *A. striata* occurred year-round in the upper 400 m, with mean numbers of 348/1,000 m^3 or 139/m^2. Highest numbers were taken in April and August 1968 (Fig. 2). Only several juvenile

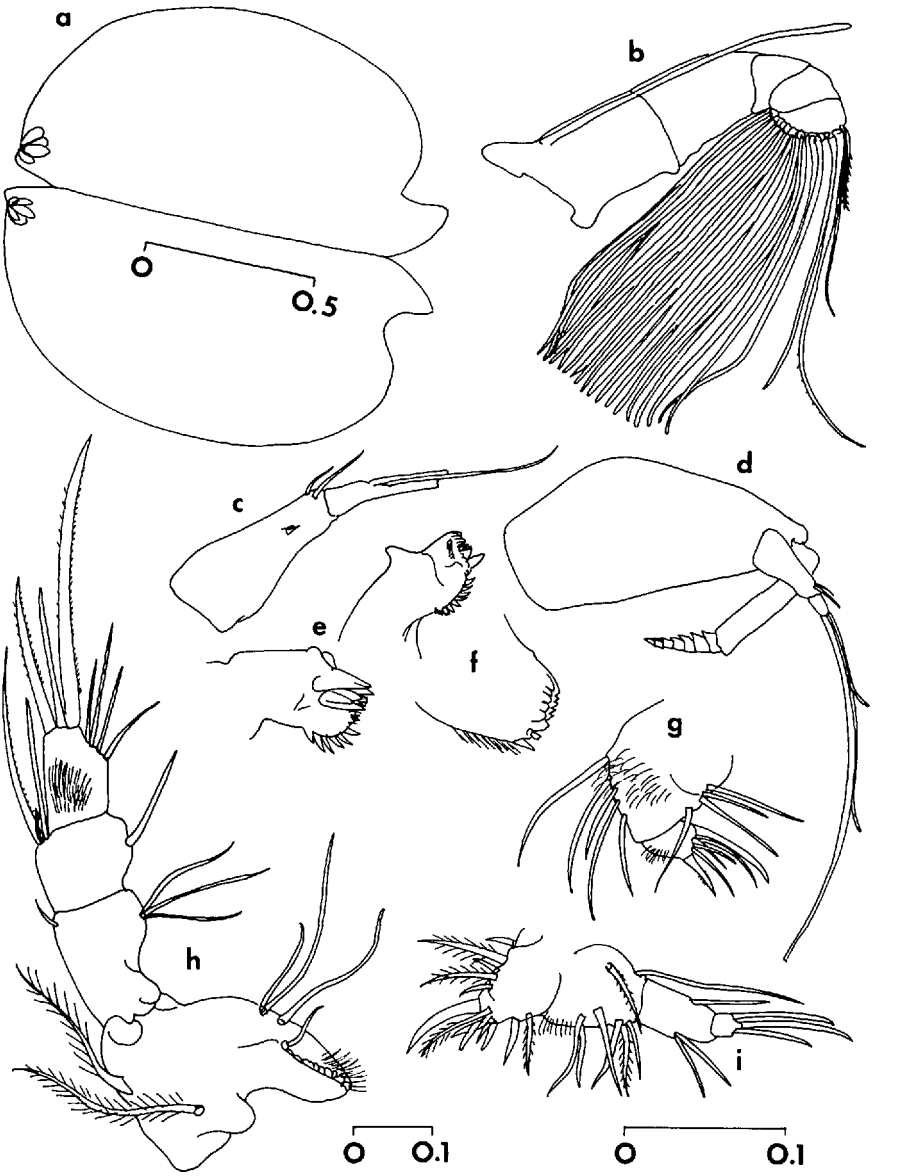


Figure 3. *Euconchoecia chierchiae aspicula*, female. a, Shell opened out; b, Frontal organ and first antenna; c, Endopodite of the second antenna, longer setae cut off; d, Second antenna, longest seta broken; e, Two views of toothrows and masticatory pad of coxa of mandible; f, Toothrow of basale of mandible; g, Endopodite of maxilla; h, Endopodite and basale of mandible; i, Fifth limb. Scale on a for a, at bottom center for d, at bottom right for b, c, e–i. Scales in mm.

specimens of *A. cucullata* were caught in hauls with 800–950 mw. Two females of *A. bispicula,* 1.02- and 0.97-mm long, were taken in October 1967 and July 1968 at Station 2B. This species was recently described (Deevey, 1978b) from a single female 1.02-mm long from the western Caribbean, and it has since (Deevey and Brooks, 1980) been recorded from the Sargasso Sea off Bermuda; it is therefore now known from 13–32°N in the western Atlantic and Caribbean Sea. A

single juvenile female, 0.98-mm long, of *A. fabiformis* was also caught in a 400–0-m haul in December 1968. This species was described from the eastern Caribbean (Deevey, 1978a) at 11°45'N off the Venezuelan coast and is thus far known only from this region.

Subfamily EUCONCHOECINAE Poulsen
Genus *Euconchoecia* Müller

A few specimens of *E. chierchiae,* the common epipelagic neritic species of this genus, were caught in August and September 1967, March to May 1968 and January 1969, 1973, and January and May 1975. This species is usually found in coastal waters and possibly may have been brought to the Barbados region with low-salinity waters from off the mouth of the Amazon or Orinoco Rivers. *E. chierchiae* has usually been figured and described as having a posterodorsal point on the right shell (Müller, 1906; Skogsberg, 1920; Deevey, 1968; Tseng, 1969). However, in his original description of the species, based on specimens from off the Brazilian coast, Müller (1890) said: "Bisweilen ist der rechte Vorspring in eine Spitze ausgezogen," implying that only some of his specimens had a posterodorsal point on the shell. Later in his 1906 Valdivia monograph he noted that different forms could be distinguished by the presence and size or absence of posterodorsal points, but due to the lack of fundamental distinctions he did not erect separate species. Because of this Skogsberg (1920) did not synonymize his *E. chierchiae* with posterodorsal points that were caught near the type locality with Müller's specimens. In the North Atlantic off Barbados and in the eastern Caribbean we once again face Müller's dilemma.

In the samples taken at Station 1B in 1963–64 three female *Euconchoecia* that lacked the posterodorsal point on the right shell were noted and briefly described as *Euconchoecia* sp. (Deevey, 1970, p. 801, fig. 1). At that time several species of *Euconchoecia* from Taiwan waters were being described, including a species without any posterodorsal points, *E. maimai* Tseng (Tseng, 1969). Another female and a male have now been found in samples collected at Station 2B in March 1968. Furthermore, a reexamination of some of the *Euconchoecia* collected at three stations off the coast of Venezuela in 1967–68 (Deevey, 1978a) yielded several more female and juvenile specimens that lacked a point at the posterodorsal corner or that had only a very tiny point on the right shell (see Fig. 5c). In nearly every sample that contained *Euconchoecia* one or more female or juvenile specimens lacked the posterodorsal point. Considerable time has been spent comparing the appendages of specimens with points with those of specimens without points and no other difference has been found that would justify naming the forms without points as a separate species. Therefore, these forms are here described as a subspecies of *E. chierchiae*. Skogsberg (1920) has given a full description of *E. chierchiae* with posterodorsal points.

Euconchoecia chierchiae Müller ***aspicula*** new subspecies
Figures 3–5

Euconchoecia sp. Deevey, 1970, p. 801, fig. 1.

Description of Female.—Shell 1.1–1.2 mm long with rounded anteroventral and posteroventral corners, no spine or point at the right posterodorsal corner or on the left rostrum, height a little less than half the length. As in *E. chierchiae* the asymmetrical glands open just below the posterodorsal corner on each shell (Fig. 3a). The frontal organ is slim and undifferentiated, reaching nearly to the tip of

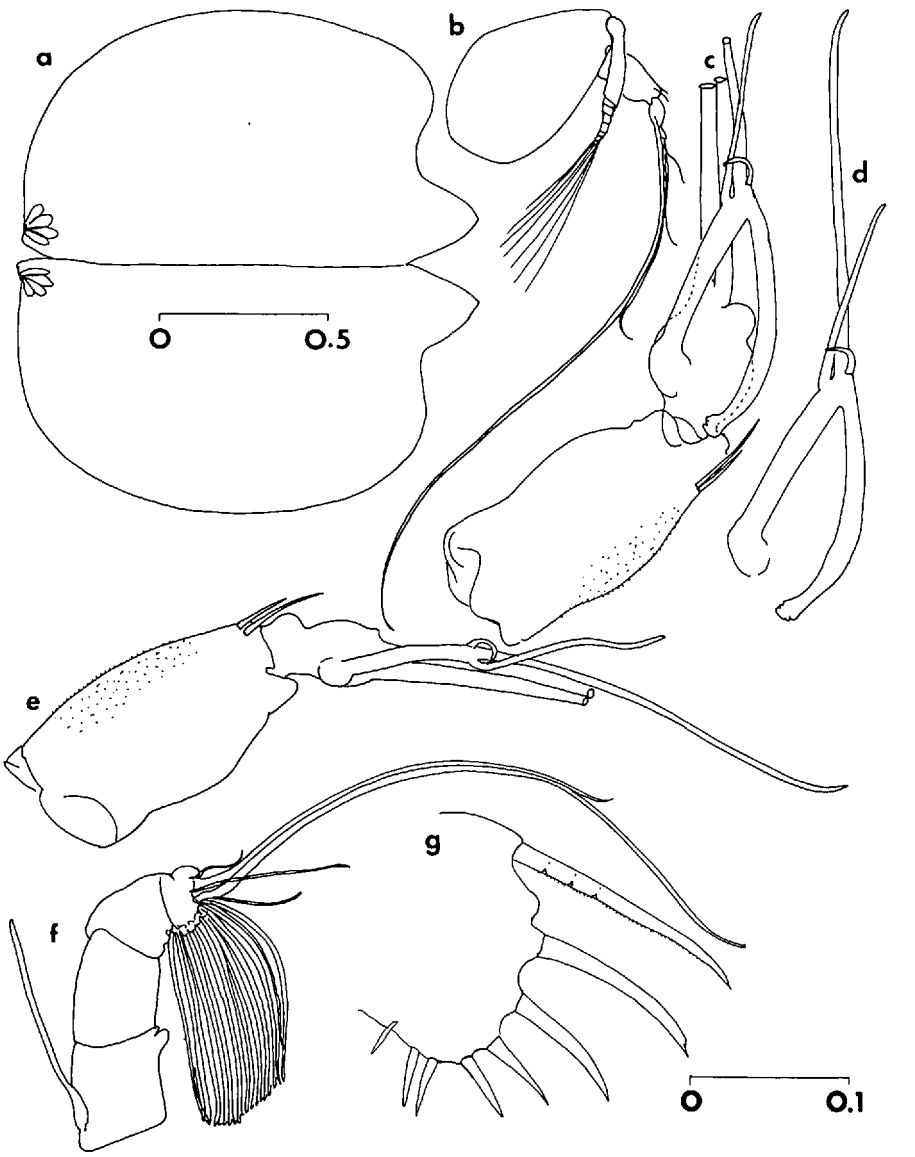


Figure 4. *Euconchoecia chierchiae aspicula*, male. a, Shell opened out; b, Left second antenna; c, Endopodite of right second antenna, longer setae cut off; d, right clasper; e, Endopodite of left second antenna, longer setae cut off; f, First antenna and frontal organ; g, Furca. Scale on a for a and b, at bottom right for c–g. Scales in mm.

the 1st antenna (Fig. 3b), which has over 20 sensory filaments as in the *E. chierchiae* female. The endopodite of the 2nd antenna has 2 bristles distally on the basal segment and 3 setae of varying lengths on the distal segment (Fig. 3d). The basal segment of the endopodite of the maxilla has 5 setae on the anterior surface and some long hairs, and 4 setae posteriorly (Fig. 3g). The endopodite of the mandible has 3 setae ventrally on the 1st segment and a tiny dorsal seta, 4 setae of which one is tiny on the 2nd segment, and 7 setae on the distal segment, one

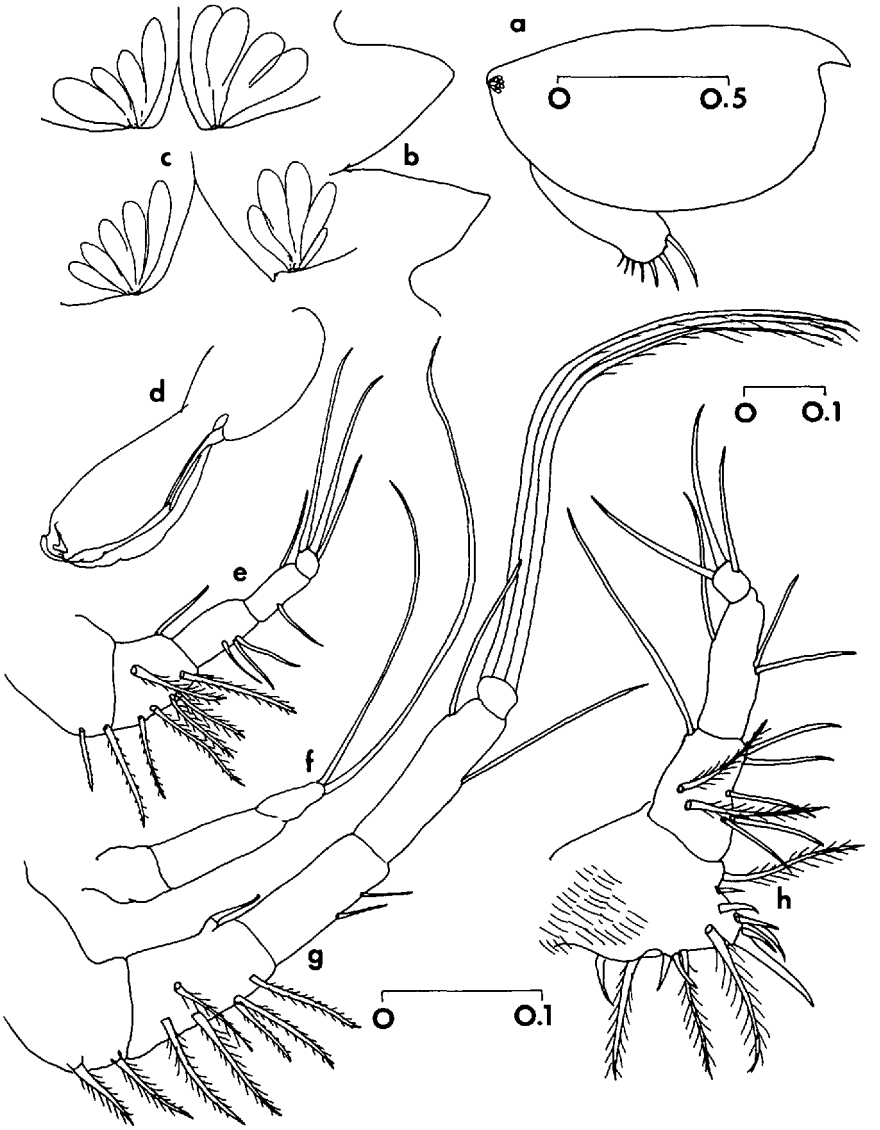


Figure 5. *E. chierchiae aspicula*. a, Lateral view of juvenile female; b, Rostrum opened out; c, Posterodorsal corners of a specimen with no points and of one with a very tiny point on right shell; d, Penis; e, Female sixth limb; f, Female seventh limb; g, Male sixth limb; h, Male fifth limb. Scale on a for a, on right margin for b–d, at bottom for e–h. Scales in mm.

of which is much longer and stronger than the others (Fig. 3h). The 5th limb (Fig. 3i) has the usual 3 setae on the distal segment, the middle seta being the longest; one female had 4 setae, with 2 ventral setae; the 2nd exopod segment has 2 ventral and 1 dorsal seta, and the 1st segment a total of 7 ventral and a long dorsal seta. The protopodite and endopodite have a total of 13 setae or bristles, of which 4 are plumose. The 6th limb (Fig. 5e) has 6 ventral setae on the 1st segment and a short dorsal seta, 2 or sometimes 3 ventral setae on the 2nd segment, and a dorsal and a ventral seta on the 3rd segment; the distal segment

has the usual 3 setae, but the dorsal seta is longer than the stronger middle seta, as is the case in "typical" *E. chierchiae* females. The furca (Fig. 4g) has 7 relatively long slim claws and a single unpaired bristle; the 1st claw has 3–4 "breaks" proximally, as in species of *Bathyconchoecia*.

Description of Male.—The shell height is approximately half the length. The posterodorsal corners are bluntly rounded, with the asymmetrical glands just below the corners (Fig. 4a). The 1st antenna is more highly developed than in the female and bears distally 2 long bare setae and 3 short ones (Fig. 4f), and on the penultimate segment there are over 20 slim filaments. The slim undifferentiated frontal organ is relatively short on the single male specimen and extends to the 3rd segment of the 1st antenna; it is also relatively short in the typical *E. chierchiae* male. The right and left clasping organs (Figs. 4c–e) are also similar to those of the *E. chierchiae* male. The longest seta on the endopodite of the 2nd antenna is very long, longer than the whole animal (Fig. 4b). The mandibles and maxillae are as in the female as is the 5th limb (Fig. 5h), although the latter is larger than in the female. The 6th limb is exceptionally large and strongly developed with 3 long plumose setae on the distal segment, as in most males of the subfamily *Conchoecinae* (Fig. 5g). The 1st segment has 6 plumose ventral setae and a short dorsal seta, the 2nd segment 2 small ventral setae, and the 3rd segment a long ventral and dorsal seta; the setation of the 6th limb is therefore the same as in the female. The penis (Fig. 5d) is of characteristic shape, constricted in the middle and swollen proximally and distally, as in the typical *E. chierchiae* male. The furca of this single male with no posterodorsal point was aberrant in that there were 7 normal claws on one side but on the other side the 5th and 6th claws were fused to produce a larger 2-pointed claw.

Remarks.—*E. chierchiae aspicula* differs from typical *C. chierchiae* only in lacking a point on the left rostrum and the right posterodorsal corner. The species described by Tseng (1969) from Taiwan Straits as *E. maimai* differs in being larger (1.4–1.5 mm long) and in that the male and female frontal organs are relatively shorter. As figured by Tseng the male 5th limb has a short dorsal seta rather than a long one, and the endopodite of the maxilla has only 4 setae on the anterior surface instead of 5, but the description of *E. maimai* is not full enough to properly compare the appendages with those of *E. chierchiae aspicula*. More recently Chavtur (1976) has described from the Sea of Japan a species of *Euconchoecia, E. pacifica,* that has no posterodorsal or rostral points. His specimens were also larger, 1.5–1.55 mm long, with rounded posterodorsal corners to the shell, had somewhat shorter frontal organs, and in the males, as in the *E. maimai* male, the right clasping organ is larger and longer than in the *E. chierchiae aspicula* male. It is highly probable that *E. pacifica* Chavtur is synonymous with *E. maimai* Tseng.

Subfamily HALOCYPRINAE Poulsen

Two species of this subfamily occur in Barbados waters, one present throughout the year and the other noted from fall to spring. *Halocypria globosa* and *Fellia cornuta* have not as yet been caught here, although the latter is known from the eastern Caribbean off Venezuela. *Halocypris inflata* occurred year-round, in highest numbers in spring and summer (see Fig. 2), with an overall mean of 157/1,000 m^3 or 62.8/m^2. Poulsen (1969) noted that *H. globosa* is rarely found in tropical waters and is more abundant in temperate latitudes, whereas *H. inflata* is more numerous between 25°N and 25°S. *Fellia bicornis* was caught occasionally between October and June from the upper 400 m, and also in some

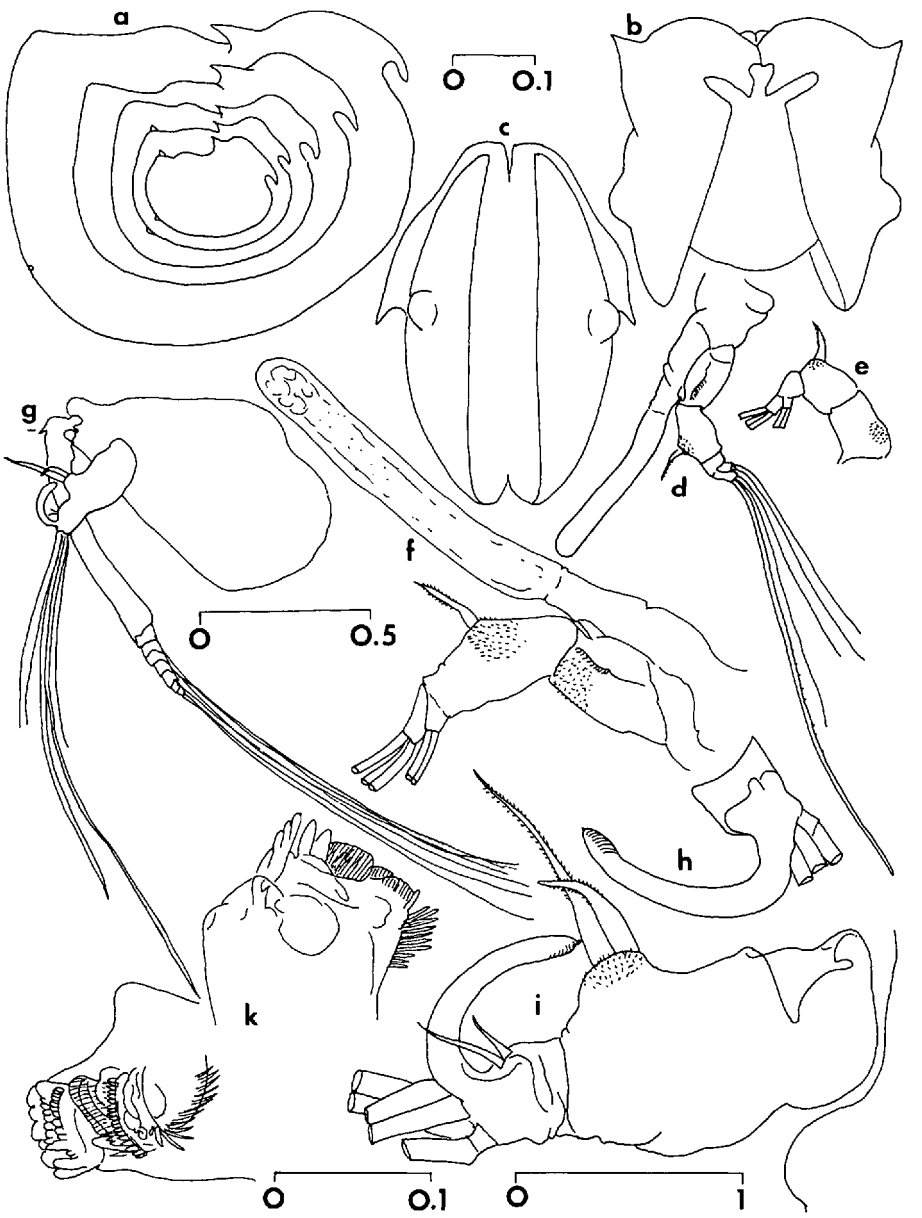


Figure 6. *Fellia bicornis*. a, Lateral view of female shell and the shells of the last four juvenile stages; b and c, Anterior and ventral views of male shell; d, Frontal organ and first antenna of male; e, First antenna of another male, setae cut off; f, First antenna and frontal organ of male, setae cut off; g, Male right second antenna; h, Male left clasping organ; i, Endopodite of male right second antenna, setae and filaments cut off; k, Two views of tooth rows and masticatory pad of coxa of male mandible. Scale at bottom right for a–c, at bottom left for h–k, near center for d, e, and g, and at top for f. Scales in mm.

deeper hauls with 900 mw, but it was not taken during the summer months. Poulsen (1969) found this species mainly in the tropical regions of all oceans, but more common in the Indian Ocean.

Brief descriptions of *Fellia bicornis* have been given by Müller (1906), Vavra

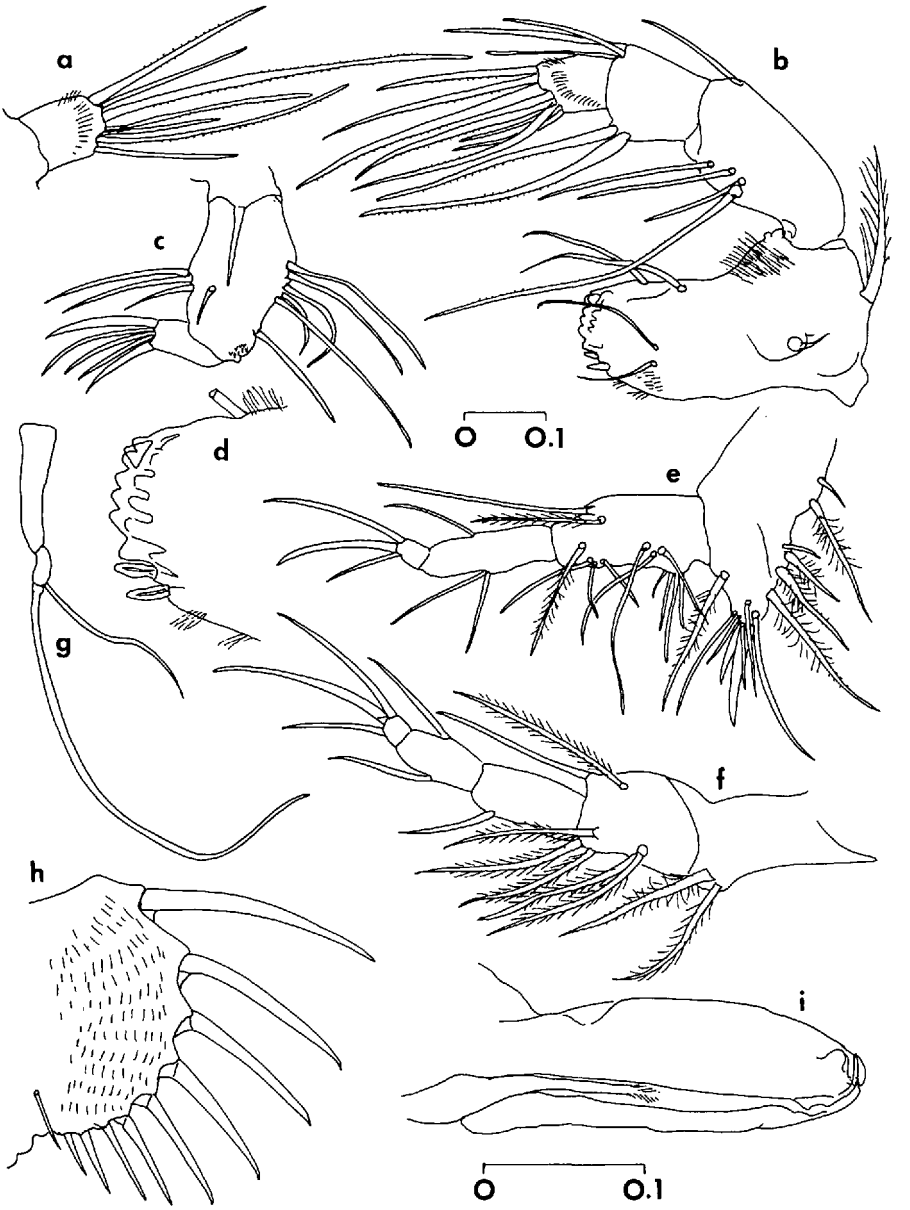


Figure 7. *Fellia bicornis*. a, Distal segment of endopodite of female mandible; b, Endopodite and basale of male mandible; c, Endopodite of male maxilla; d, Toothrow of basale of male mandible; e, Male fifth limb; f, Male sixth limb; g, Male seventh limb; h, Male furca; i, Penis. Scale near center for a–c, e–i, at bottom for d. Scales in mm.

(1906, as *Halocypris taurina*) and Poulsen (1969), but as all the appendages have never been figured they are illustrated in Figures 6 and 7. Usually only a few individuals were taken per tow, but a number of mature and juvenile specimens were caught in May 1973. Ten females ranged in length from 1.9–2.0 mm and 10 males from 1.76–1.9 mm. Ten Stage VI specimens with 7 claws on the furca were

1.36–1.44 mm long, 12 Stage V individuals were 1.0–1.08 mm long, 3 Stage IV juveniles were 0.76–0.78 mm long, and 4 Stage III specimens with 4 pairs of claws on the furca were 0.62–0.64 mm long. The increase in size from Stage III to the mature female is illustrated in Figure 6a. The shape of the shell is the same in both sexes and is distinctive, with a sharp horn on the shoulder vaults and a rounded bump on each side below the horn (Figs. 6b and c). The male differs from the female only in having clasping organs on the endopodites of the second antennae and a penis. The frontal organ and first antennae are similar in both sexes (Figs. 6d–f). Curiously, the basal segment of one first antenna has a longitudinal spiny ridge on the outer side (Figs. 6d, f), whereas the other first antenna has a rounded spine-covered mound on its basal segment (Fig. 6e). This is also the case in *Fellia cornuta,* but *F. dispar* has only the spiny mounds. The right and left clasping organs of the male are hooklike and fairly similar in size and shape (Figs. 6h, i); in the other subfamilies of halocyprids the right clasper is almost invariably notably larger. One small difference between the sexes was noted in the endopodite of the mandible, in that the largest bristle on the distal segment was longer in the female (Fig. 7a) than in the male (Fig. 7b). However the setation of the 5th and 6th limbs (Figs. 7e, f) is similar. The furca (Fig. 7h) has 8 pairs of straight slim claws and an unpaired bristle. The penis is slim and tapers to the tip (Fig. 7e).

Subfamily CONCHOECINAE Müller
Genus *Conchoecia* Dana

Various attempts have been made in the past to divide this genus into a number of genera, but none have been thoroughly satisfactory. Claus (1890) proposed a number of genera for the species he knew. Müller (1906) described many new species, most of them caught on the Deutschen Tief-See Expedition, but he did not consider the differences between the species sufficient to justify erecting new genera; instead he devised the system of grouping more or less related species together in groups. Granata and di Caporiacco (1949) proposed a few new genera, and Poulsen (1973) later divided all known species into 17 genera. Recently Martens (1979) has pointed out that 10 of these generic names are *nomina nuda,* as no type species were designated for them. Ten generic names are valid and Martens proposed a few more for the species he found in the southeast Pacific off Chile. More than 100 species of *Conchoecia* have been described and their interrelationships are not as yet sufficiently known to warrant splitting the species of Conchoecinae into many genera. In this report the valid generic names will be put in parentheses as sub-genera, and Müller's (1906) system of grouping species into more or less natural groups will be followed.

Spinifera Group Müller

Six members of this group, which Poulsen (1973) placed in the genus *Paraconchoecia,* now a nomen nudum, were recorded: *C. spinifera, C. oblonga, C. echinata, C. allotherium, C. aequiseta* and *C. inermis. C. oblonga* was one of the commonest species year-round at Station 2B, with mean numbers of 219/1,000 m^3 or 87.6/m^2. It was most numerous in spring and summer (see Fig. 2) with highest numbers in July. Both form A, with the right asymmetrical gland at the posteroventral corner, and form B with the gland moved forward on the ventral margin were present, although form B was noted more frequently. *C. spinifera* occurred in small numbers for most of the year, and *C. echinata* was taken

occasionally, most commonly from May to July. A single *C. aequiseta* male was caught in January in a tow with 950 mw, and a female in April in a 900–0-m haul. A female and a juvenile *C. inermis* were noted from 1,000–0-m tows in March and May and another female from within the upper 400 m at Station 2B in May. Also, 3 males and 3 females of *C. allotherium* were caught at a station 12 miles off the west coast in May in a haul with 895 mw. This species is closely related to *C. oblonga*; the male was described by Müller (1906) and distinguished from the male *C. oblonga* by minute differences in the frontal organ and the armature of the 1st antenna. Müller was unable to differentiate the females from female *C. oblonga*.

C. allotherium has been rarely mentioned. Angel and Fasham (1975) listed it from 10½–18°N in the eastern Atlantic. Müller (1906) gave its distribution as 14°N–35°S in the Atlantic and ca. 10°N–10°S in the Indian Ocean. It has also been recorded from the eastern Caribbean (Deevey, 1978a) and from about 0–16°S in the Atlantic (Deevey, 1974). Poulsen (1973) listed a juvenile female and two juvenile males as possibly belonging to this species, but these specimens may have been *C. oblonga*. Angel (1979, table 7) included *C. allotherium* with other species he considered principally epipelagic species associated with South Atlantic Central Water. While examining the three males caught off Barbados I noticed that the furca differed from that of *C. oblonga* in that only the 2nd to 4th claws were larger and curved and the 5th to 8th pairs of claws were short and straight. In *C. oblonga* the 2nd to 5th claws are large and curved (see Figs. 8h and 10f). In checking the other males of *C. allotherium* in my possession it was apparent that this was a character that quickly distinguishes *C. allotherium* from *C. oblonga*. Three *C. allotherium* females were caught in the same sample as the males, so it is now possible to describe the female.

Conchoecia allotherium Müller
Figures 8–10

C. allotherium G. W. Müller, 1906, p. 59, pl. 11, figs. 15–19.
C. allotherium, G. Deevey, 1974, p. 361, figs. 2i–n.
?"*Paraconchoecia*" *gerdhartmanni* J. Martens, 1979, p. 334, figs. 15 and 17.

Description of Female.—Shell 1.6–1.7 mm long, slim, height 35–40% of length, dorsal and ventral margins straight, anteroventral corner rounded, posteroventral corner somewhat rounded, right asymmetrical gland at the posteroventral corner as in *C. oblonga* form A, a small point and usually a second small spine at the posterodorsal corner of the right shell (Fig. 8a). The sculpturing of the shell consists of faint longitudinal lines paralleling the ventral margin, most noticeable anteriorly. The 1st antenna is similar to that of the *C. oblonga* female, long and slim, with a relatively long bare dorsal seta distally on the 2nd segment. The principal seta has long hairs proximally on the anterior surface and short spinules mostly on the posterior surface of the distal half (Fig. 8d). On these three females the capitulum of the frontal organ does not extend quite as far beyond the distal end of the 1st antenna as it does in *C. oblonga*; in one female the stalk of the frontal organ ended even with the distal end of the 2nd segment of the antenna, but in the other two females it extended beyond the antenna. The capitulum of the frontal organ of the three females had a sharp point distally (Fig. 8b). The capitulum has numerous spinules on the ventral surface, but only a few proximally and dorsally. As in *C. oblonga*, the basal segment of the exopodite of the 2nd antenna is relatively short, only 32–34% the length of the shaft (Fig. 9i). Four of the setae on the distal segment of the endopodite are subequal (Fig. 8c), and the

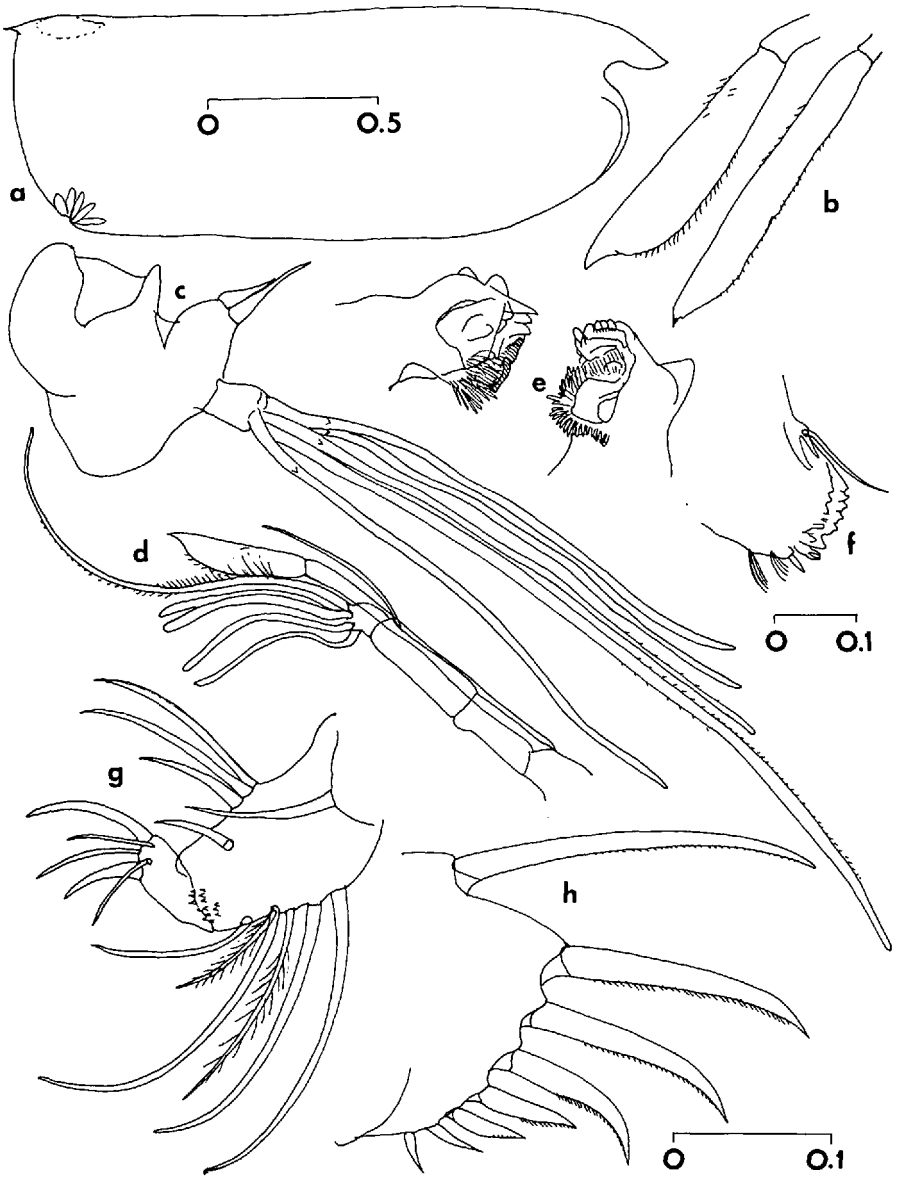


Figure 8. *Conchoecia allotherium,* female. a, Lateral view of shell; b, Capitulum of frontal organs of two females; c, Endopodite of second antenna; d, First antenna and frontal organ; e, Two views of toothrows and masticatory pad of coxa of mandible; f, Toothrow of basale; g, Endopodite of maxilla; h, Furca. Scale on a for a, at center right margin for d, at bottom right for b, c, e–h. Scales in mm.

longest seta is somewhat broadened distally and bears spinules. The setation of the mandible differs somewhat from that of *C. oblonga*. The basale is exceptionally elongated and narrow (Fig. 10b). The distal segment of the endopodite has the usual 7 setae, but the two most distal are exceptionally large and spinous and the others are short and thin. The 2nd segment of the endopodite has 3 slim weak setae distally and 2 strong spinous setae, one of which is exceptionally long; in

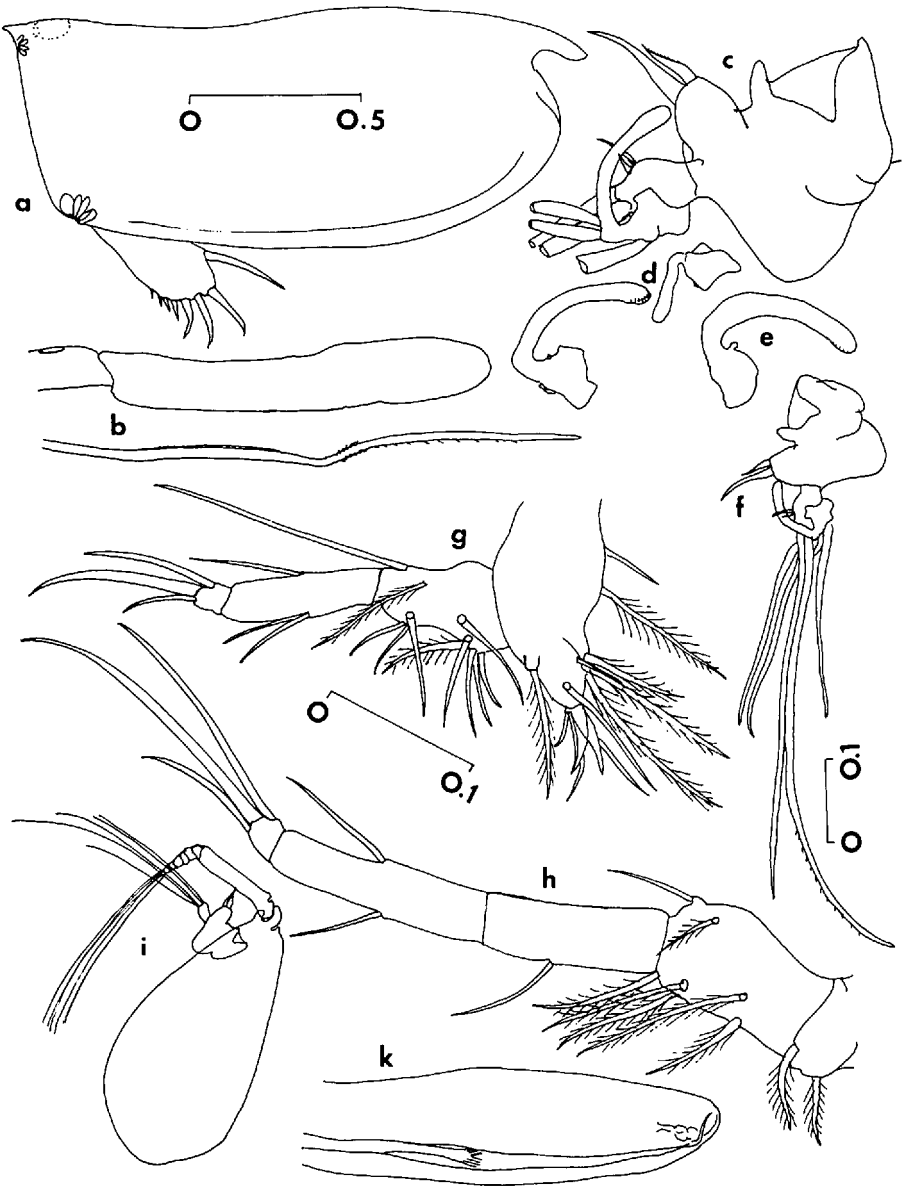


Figure 9. *C. allotherium* male: a, Lateral view of shell; b, Capitulum of frontal organ and proximal secondary seta of 1st antenna; c, Endopodite of right second antenna, distal setae cut off; d, Right and left claspers; e, Right clasper of male *C. oblonga*; f, *C. allotherium* male right second antenna; g, Female fifth limb; h, Female sixth limb; i, Female second antenna; k, Penis. Scale on a for a, at lower center for b–e, g, h, k, on right margin for f, i. Scales in mm.

C. oblonga this seta is shorter and weaker. The 1st segment of the endopodite has a short dorsal seta and 4 ventral setae, one of which is much longer; in *C. oblonga* there are only 3 ventral setae with one shorter and 2 longer weak setae of the same length (Fig 10a). The distinguishing setae are indicated by arrows on Figures 10a and 10b. The tooth rows of the basale and coxale are similar in the

two species, as is the setation of the endopodite of the maxilla (Fig. 8g). There is a cluster of short sharp spines at the distal end of the basal segment of the maxilla endopodite that was also noted on the *C. oblonga* maxilla.

The exopodite of the 5th limb has 10 setae plus the long dorsal seta on the 1st segment, 1 dorsal and 2 ventral setae on the 2nd segment, and the usual 3 setae on the distal segment, as in *C. oblonga*; the protopodite and endopodite have a total of 13 setae or bristles (Fig. 9g). The 1st exopod segment of the 6th limb (Fig. 9h) has 6 plumose setae and a short bare dorsal seta, the 2nd segment 1 ventral seta, the 3rd a dorsal and a ventral seta and the distal segment the usual 3 setae, with the middle seta the longest and strongest and the ventral seta the shortest.

The furcal claws provide the readiest means of differentiating *C. allotherium* from *C. oblonga*. The 1st claw is noticeably longer in *C. allotherium*; if drawn down beside the 2nd claw it extends as far as or almost to the tip of the 2nd claw. The 2nd to 4th pairs of claws are larger and somewhat curved and the 5th to 8th pairs shorter and straight (Fig. 8h), whereas in *C. oblonga* the 2nd to 5th pairs of claws are larger and more strongly curved (Fig. 10f). Neither species has a single bristle on the furca.

The male *C. allotherium* differs from the male *oblonga* in having a double row of spinules near the tip of the proximal secondary seta (the b seta) and no spinules on the capitulum of the frontal organ (Figs. 9b, 10c), as well as in the characters of the furcal claws and the setation of the endopodite of the mandible. Also the right clasping organ differs in shape (compare Fig. 9d with 9e). Another minute difference noted is that the setae on the 1st exopodite segment of the 6th limb are smaller and more reduced in the *C. oblonga* male (see Figs. 10d and e).

Remarks.—Judging from Martens' (1979) description and figures of "*Paraconchoecia*" *gerdhartmanni*, this species is very closely related to if not synonymous with *C. allotherium*. It is slightly larger than *allotherium*, males being 1.56–1.69 mm long and females 1.63 to 1.89 mm in length, whereas my *allotherium* males are 1.4–1.6 mm and females 1.6–1.7 mm long. A number of species, including *C. oblonga* are larger in the Pacific than in the Atlantic. As described by Martens the b seta of the male 1st antenna has a single row of tiny spinules distally, instead of a double row as in *C. allotherium* (Figs. 9b, 10c), and the b seta is almost as long as the e seta. Conceivably Martens missed seeing the 2nd row of tiny spinules as usually only one row is fully visible. Aside from these slight differences in the length and in the armature of the b seta of the male 1st antenna *P. gerdhartmanni* appears to be identical to *C. allotherium* in the proportions of the shell and the morphology of the appendages.

Elegans Group Müller

C. (Discoconchoecia) elegans occurred in small numbers year-round, but was most numerous in spring and fall. Females were 1.15–1.3-mm long and males 1.2–1.3 mm in length.

Procera Group Müller

Four species of this group were taken: *C. procera, C. macroprocera, C. microprocera,* and *C. convexa. C. procera* and *C. microprocera* together were the most abundant ostracods in these waters. A male of *C. convexa,* 1.41 mm long, was caught in a 900–0-m haul in April 1968, and a single male *C. macroprocera,* 1.2-mm long, was taken in May in a tow with 895 mw. The total numbers of adults of *C. procera* and *C. microprocera* and of the *procera* species including

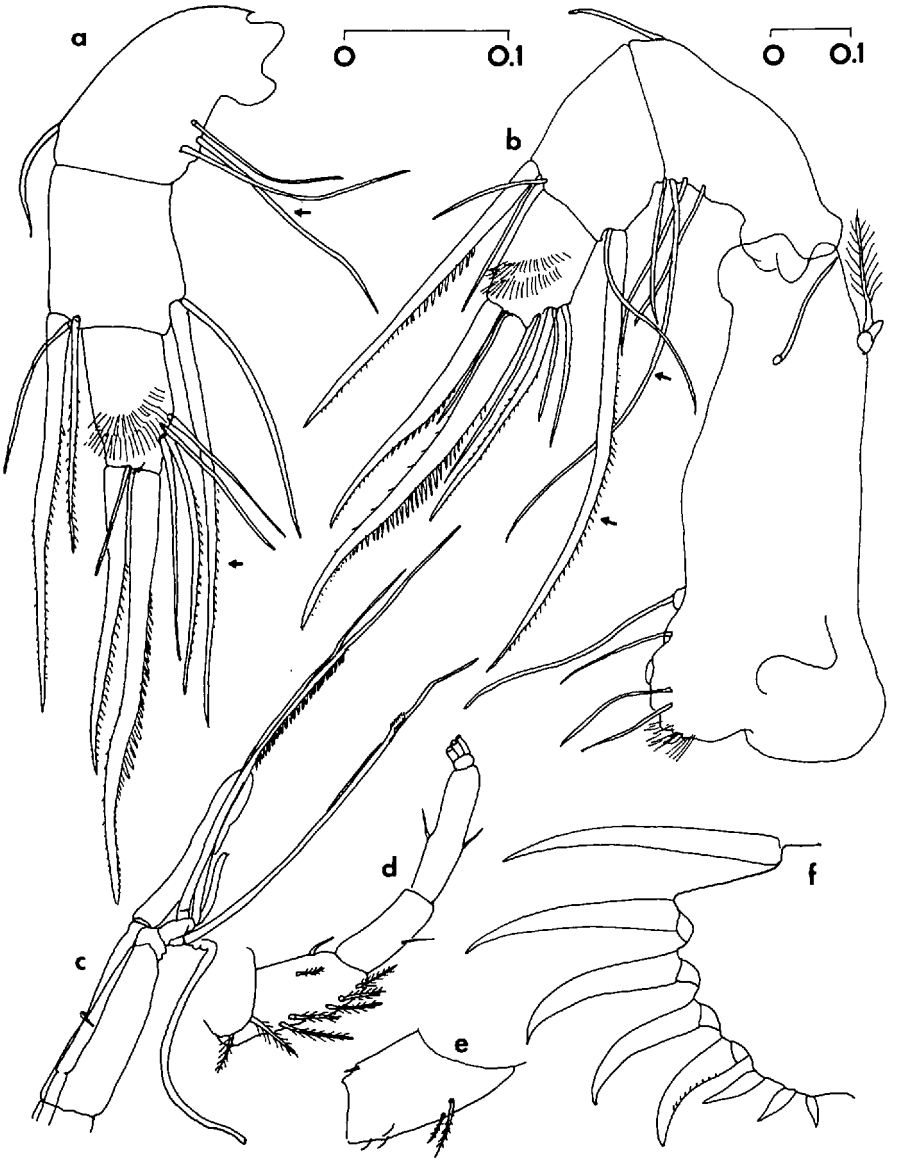


Figure 10. a, Endopodite of mandible of *C. oblonga* male; b, Endopodite and basale of mandible of *C. allotherium* male; the arrows on a and b indicate the two setae that differ in length in the two species; c, Frontal organ and 1st antenna of *C. allotherium* male; d, Sixth limb of *C. allotherium* male, long distal setae cut off; e, Basal segment of exopodite of sixth limb of *C. oblonga* male; f, Furca of *C. oblonga* male. Scale at top center for a, b, f, at top right for c–e. Scales in mm.

juveniles taken at Station 2B are shown in Figure 11. Total numbers including juveniles were highest in September 1967, January to May and July 1968. Maximal numbers were found in April, when total numbers of ostracods were also greatest. As was the case in the Sargasso Sea (Deevey and Brooks, 1980), *C. procera* females and males were more abundant when *C. microprocera* adults were not. The total numbers of the *procera* species yielded a mean of 1,081/1,000 m^3 or

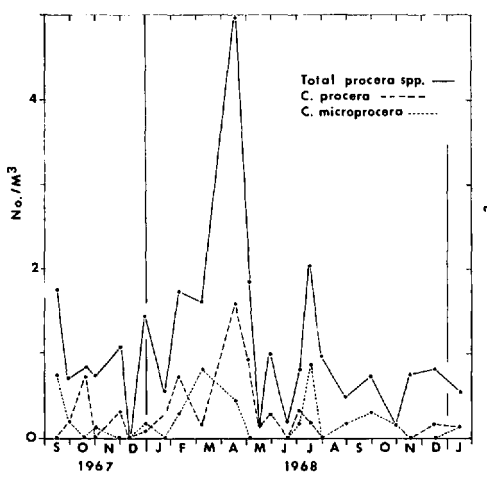


Figure 11. (Left) Variations in numbers/m³ of *C. procera*, dashed line, *C. microprocera*, dotted line, and total *procera* species including juveniles, solid line, from September 1967 to January 1969 at Station 2B.

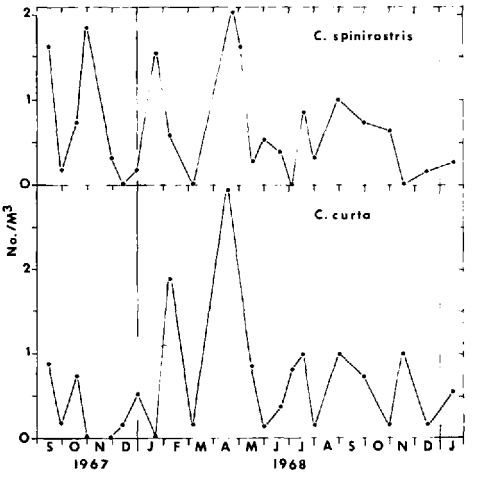


Figure 12. (Right) Variations in numbers/m³ of *C. curta* and *C. spinirostris* from September 1967 to January 1969 at Station 2B.

432.4/m². The *C. procera* adults gave a mean of 258/1,000 m³ or 103.2/m² and *C. microprocera* adults a mean of 188/1,000 m³ or 75.2/m².

Acuminata Group Müller

C. (Conchoecetta) acuminata occurred fairly regularly in small numbers for most of the year. Females were 2.92–3.2-mm long and males 2.05–2.3 mm long. These specimens were therefore somewhat larger than the small forms Poulsen (1973) found between 25°N and 25°S in the Atlantic, but were on the average smaller than those recorded from the Sargasso Sea (Angel, 1979; Deevey, 1968; Deevey and Brooks, 1980). *C. giesbrechti*, the other member of this group, has not yet been recorded from the western North Atlantic.

Rotundata Group Müller

C. rotundata, as described from the Sargasso Sea (Deevey, 1968) occurred year-round at Station 2B. This is the species listed by Angel (1979) as *C. rotundata* form 15. Higher numbers were noted between September and February, and a mean of 153/1,000 m³ or 61.2/m² was obtained for the period studied. *C. nasotuberculata*, males and females 0.84–0.88-mm long, was noted occasionally during the year and *C. pusilla* was recorded only on several occasions in January, March and April from hauls with 900 mw. A single *C. skogsbergi* male was taken in a 900–0-m tow in May.

Curta Group Müller

Three species of this group that Claus (1890) placed in the genus *Mikroconchoecia* were taken: *C. curta, C. echinulata* and *C. stigmatica*. With *C. spinirostris, C. curta* was second in year-round abundance after the combined *procera* species, with mean numbers of 654/1,000 m³ or 261.6/m². Highest numbers were

recorded in February and especially in April (see Fig. 12), when the *procera* species and *C. spinirostris* were also most abundant. *C. echinulata* was considerably less numerous here than farther north in the Sargasso Sea (Deevey and Brooks, 1980) and males were noted only occasionally. The females, if present, were not distinguished from those of *C. curta*. Males and females of *C. curta* were 0.78–0.80 mm long.

Juveniles of *C. stigmatica* were often noted in the upper waters, but only 3 mature specimens—a female 1.0 mm long and 2 males 1.2 and 1.25 mm long—were caught in 900–0-m hauls in January, March and April. Most of the records for this species are from tropical and subtropical waters, including Barney's (1921) "Terra Nova" specimens from 18°–35°S in the Pacific north of New Zealand, but Angel and Fasham (1975) listed it as occurring from 30°–60°N in the eastern Atlantic, and Angel (1979) considered it a medium to high latitude deep mesopelagic to bathypelagic species. However, it is not uncommon in the Caribbean Sea and Gulf of Mexico (Deevey, 1978a, unpublished data).

Bispinosa Group Müller

Both Granata and di Caporiacco (1949) and Poulsen (1973) placed the members of this group in the genus *Orthoconchoecia* without naming a type species, but Martens (1979) has validated this name by designating *O. striola* (Müller 1906) as the type. *C. atlantica, C. bispinosa* and *C. secernenda* occurred in small numbers more or less year-round. *C. secernenda* was the least abundant species and was not noted at Station 2B during the second half of 1968. Females of *C. atlantica* were 3.4–3.65 mm long and males 3.4–3.5 mm long; *C. bispinosa* females had a length range of 1.75–1.9 mm and males of 1.6–1.75 mm, *C. secernenda* females of 2.2–2.42 mm and males of 2.1–2.3 mm. Angel (1979) found *C. atlantica* principally associated with South Atlantic Central Water and *C. bispinosa* and *C. secernenda* mainly associated with North Atlantic Central Water in the eastern North Atlantic.

Angel (1979) suggested a relationship between the distribution of *C. bispinosa* and the 13° isotherm, which at Station 2B was at about 300 m. This might partially explain why this species occurred regularly in the 400–0-m tows off Barbados, but was found only in the 500–1,000 m samples off Bermuda where the 13° isotherm is below 500-m depths. However, this doesn't explain why *C. bispinosa* is more abundant than *C. secernenda* in the waters off Barbados and considerably less adundant than that species in Bermuda waters. The overall distribution of these species in the Atlantic is similar; *bispinosa* is known from 43°N–42°S and *secernenda* from 40°N–38°S. *C. atlantica,* which has been recorded from 40°N–37°S in the Atlantic, was also more commonly noted in tropical waters than in the Sargasso Sea. None of these species has been found south of the Subtropical Convergence in the Atlantic.

Magna Group Müller

Ten species of this group were noted. *C. spinirostris* was a dominant species year-round, and with *C. curta* second in abundance after the *procera* species with a mean of 653/1,000 m^3 or 261.2/m^2. *C. spinirostris, C. porrecta,* and *C. parthenoda* were placed by Poulsen (1973) in the genus *Spinoecia,* now a nomen nudum. *C. spinirostris* and *C. porrecta* have since been put in the genus *Porroecia* by Martens (1979), who included *C. parthenoda, C. magna, C. lophura, C. parvidentata, C. macrocheira, C. subarcuata,* and *C. hyalophyllum* in the genus *Conchoecia.* Of these *C. porrecta, C. parthenoda,* and *C. magna* occurred year-

round in the upper 400 m at Station 2B; the other species were noted more rarely or only from greater depths.

C. spinirostris was most numerous during September and late October 1967 and in January and April 1968 (Fig. 12); lesser maxima were noted in July and late August to October, possibly indicating 5–6 generations during a year. *C. magna* was more abundant in fall and spring, with a mean of 104/1,000 m^3 or 41.6/m^2. Males had a length range of 1.7–2.0 mm and females of 1.8–2.0 mm. The data for *C. parthenoda* gave a mean of 134/1,000 m^3 or 53.6/m^2, and for *C. porrecta* of 87/1,000 m^3 or 34.8/m^2. *C. subarcuata* was noted occasionally during the year, and *C. pseudoparthenoda* and *C. macrocheira* juveniles less commonly. Two females 1.6 and 1.7 mm long and a 1.6 mm male of *C. hyalophyllum* were taken in a February sample at Station 2B and in a deeper tow in May. Female and juvenile specimens of *C. lophura* were caught in January and March in 1,000–0-m or 900-mw hauls. *C. parvidentata* was noticed with certainty only from a September 1963 400-m sample (Deevey, 1970).

Loricata Group Müller

Only a female, a male and a juvenile *C. loricata* were noted in samples collected in January, March and April from 400–0- and 1,000–0-m hauls. The closely related *C. ctenophora* was not found, and indeed has not been recorded from the western North Atlantic, although Angel and Fasham (1975) list it as occurring from 18°–53°N in the eastern Atlantic. Its absence is all the more puzzling as Angel (1979) found it a principally epipelagic species associated with North Atlantic Central Water in the eastern Atlantic together with other species all of which are common in the western Atlantic.

Serrulata Group Skogsberg

This group contains two not closely related species, *C. serrulata* and *C. concentrica*, which Poulsen put in the genus *Pseudoconchoecia*. *C. serrulata* is a Southern Hemisphere species; only *C. concentrica* occurred off Barbados. It was taken occasionally during the year at Station 2B in subsurface samples as well as from greater depths, and is a common epipelagic species in the Caribbean Sea and Gulf of Mexico. Although Angel and Fasham (1975) recorded it only from 18°N in the eastern Atlantic, Poulsen (1973) listed several specimens between 3° and 46°N, and it is sometimes found in the Sargasso Sea off Bermuda (Deevey, 1968). It is also one of the few species found in the waters over the Cariaco Trench where it constituted 20.5% of the total numbers of ostracods in a 50-m sample collected in March 1968 (Deevey, 1978a). Females have a length range of 1.5–1.8 mm and males of 1.4–1.5 mm.

Imbricata Group Müller

Few specimens belonging to this group were taken. *C.* (*Conchoecissa*) *imbricata* was noted only occasionally at Station 2B during the first year studied; few mature specimens were caught in the 0–400-m tows or the deeper hauls. A female was 3.0 mm long, and several males ranged from 2.16–2.4 mm in length. *C.* (*Conchoecissa*) *ametra* was represented by a single shell 3.0 mm long in a January sample collected with 950 mw. Angel (1979) considered *C. imbricata* a widespread mesopelagic species in the eastern North Atlantic, and it also occurs widely in small numbers throughout the Caribbean Sea and Gulf of Mexico. In the Atlantic its range is from 65°N–55°S. *C. ametra* has been listed as a medium

to high latitude deep mesopelagic to bathypelagic species (Angel, 1979) and there are only several records of its occurrence in the Caribbean Sea (unpublished data). Its range in the Atlantic is 64°N–44°S. Angel and Fasham (1975) found it more numerous between 30° and 60°N in the eastern Atlantic.

Alata Group Müller

A single male *C.* (*Alacia*) *valdiviae*, 5.52 mm long, was caught 12 miles off the west coast of Barbados in a January tow with 900 mw. This is a striking species, deep red in color, the largest and bulkiest halocyprid, which Angel (1979) classed as a shallow to deep mesopelagic species associated with Antarctic Intermediate Water in the eastern Atlantic where he recorded it from 11°–18°N, 20°W. Kornicker (1968) found this species at 28°N in the northeastern Gulf of Mexico, and it has been noted to 47°S in the Atlantic and to 58°S in the Indian Ocean. The armature of the male 1st antenna is quite different from other members of this group; it consists of about 65 very tiny teeth, whereas other species of the *Alata* group have peg-like teeth that usually stand out at right angles to the seta.

Daphnoides Group Müller

C. (*Conchoecilla*) *daphnoides*, a widespread shallow mesopelagic species, was noted on relatively few occasions during the year from 300 or 400–0- and 900–0-m hauls. Most of the specimens were juveniles; males were 2.7–2.9 mm long and no females were taken. *C. daphnoides* has been recorded from 63°N–42°S in the Atlantic, but not south of the Subtropical Convergence. It has been found from 40°N–51°30′S in the Pacific and about 10°N–43°S in the Indian Ocean and Indonesian Seas.

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